Greetings and welcome to the **AUGUST 2016** edition of the WDFW Climate News Digest. The purpose of this newsletter is to provide highlights and links to climate change news, events and resources for WDFW staff. Feedback or suggestions for items to include in future editions are appreciated – many *thanks* to those who have sent links and references and please keep them coming.

Thanks for contributions this month from, Bob Vadas, Richard Harris, Chris Sato, Wendy Connally, Hannah Anderson, Jane Atha and Teresa Scott. Other sources for news include: Point Blue Conservation Science, NPLCC Climate Science Digest, Climate.gov, NOAA Climate Newsletter, and "BioClimate", the newsletter of the USGS Climate Science Centers and the e-Mission Control newsletter from DNR. Contact Lynn for information about subscribing directly to these newsletters.

CLIMATE ADAPTATION IN PRACTICE

Suquamish Build Resilience to Ocean Acidification Through Education – *from Climate.gov*
Changing ocean chemistry could have a disastrous impact on shellfish and fisheries in Puget Sound. The Suquamish Tribe is working with partners to inform the public about this problem while they elicit support for research and monitoring the issue.

National Park Service Director Talks Climate Change

Climate change is the biggest challenge the National Park Service has faced in its 100-year history, according to NPS Director Jonathan Jarvis. Climate Central sat down with Jarvis to talk about the types of threats that climate change poses, what NPS is doing to confront those threats, and how he hopes to inspire the next generation of stewards. Learn more >>

USFWS prepares a draft Climate Change Vulnerability Assessment for the Quilcene National Fish Hatchery

The climate change vulnerability assessment (CCVA) for Quilcene NFH is intended to ensure that the hatchery will be able to provide coho salmon for harvest well into the future, despite impacts from climate change. The CCVA is designed to provide information about the predicted climate change impacts (for 2040) and identify adaptive strategies that may be used to reduce or eliminate the NFH's vulnerability. To review a copy of the draft, please contact Lynn.

RESOURCES

Access climate-related reports issued by government agencies and scientific organizations *from Climate.gov*
This new feature includes lists and summaries of recent reports.

EPA Report Tracks our Changing Climate – *from EPA*
The U.S. Environmental Protection Agency (EPA) recently released a report that shows clear evidence of long-term changes to our climate, and highlights impacts on human health and the environment in the United States and around the world. The report, Climate Change Indicators in the United States, features observed trend data on 37 climate indicators, including U.S and global temperatures, ocean acidity, sea level, river flooding, droughts and wildfires. This fourth edition of the report, which was last published in 2014, provides additional years of data for previously-published indicators and adds seven new indicators: heat-related illnesses; West Nile Virus; river flooding; coastal flooding; Antarctic sea ice; stream

temperature; and marine species distribution. The report also features a special section that highlights the many connections between climate change and human health. Information about climate change: www.epa.gov/climatechange

Climate Change Basics – *from the Climate Commons*
The Climate Commons offers a starting point for discovery of climate change data and related resources, information about the science that produced it, and guidance for applying climate change science to conservation in California. Get started learning about the basics of climate change through helpful Climate Commons articles such as About General Circulation Models and Why So Many Climate Models?

Final Products released for the Washington-British Columbia Transboundary Climate-Connectivity Project – *from UW Climate Impacts Group*
This project engaged science-practice partnerships to identify potential climate impacts on wildlife habitat connectivity and adaptation actions for the transboundary region of Washington and British Columbia. Products include a project overview report, additional reports describing key findings for 13 case studies, and an interactive project gallery on the online mapping platform, Data Basin. This project gallery includes all project reports and assessment materials, including interactive and downloadable habitat connectivity and climate datasets. Available **here**.

NOAA releases draft Regional Climate Science Action Plans
The Regional Action Plans will identify key actions to implement the NMFS Climate Science Strategy in each region over the next 5 years. The overall goal is to *increase the production, delivery and use of climate-related information in stewardship of marine and coastal resources*. Many of the actions, products and services are expected to be of use to States with marine/coastal resource management responsibilities. Input on the priorities and actions in the Regional Climate Science Action Plans is welcome.

Which emits more carbon dioxide: volcanoes or human activities? – *from Climate.gov*
Human activities emit 60 or more times the amount of carbon dioxide released by volcanoes each year. Read more »

Adaptation Clearinghouse 2.0 Launches With Tools for Adaptation Professionals – *from the Georgetown Climate Center*
The Adaptation Clearinghouse was re-launched today with a fresh makeover and new tools to assist state policymakers, resource managers, academics, and others who are working to help communities adapt to climate change. The Clearinghouse, which was originally launched in 2011, contains more than 2,000 adaptation resources.

NOAA produces a new guide for Climate Change and Coastal Conservation – *from NOAA*
Climate change is altering coastal environments and how conservation is approached. To address this challenge, NOAA's Office for Coastal Management has produced a new Guide for Considering Climate Change in Coastal Conservation, along with a companion How to Consider Climate Change in Coastal Conservation self-guided online resource.
These products are now live on NOAA's Digital Coast under "Training" and will soon be found on the Green Infrastructure topics page. Together, these products help practitioners evaluate how their conservation efforts can endure amid changing conditions, placing communities and natural environments in the best position to adapt.

Being Prepared for Climate Change: A Workbook for Developing Risk-Based Adaptation Plans – *from EPA*

This EPA workbook provides a step-by-step guide for communities and other organizations developing risk-based climate change adaptation plans. The guide and new interactive online companion tool help users create a vulnerability assessment and develop an action plan to reduce the most pressing risks. Learn more >>

LEARNING OPPORTUNITIES

Tuesday, August 23rd, 1:30-2:30 (Pacific), webinar, "Assessing Cultural Resource Vulnerability to Climate Change"
Presenter: Caitlin Ranking, Klondike Goldrush National Historic Park, register here.

September 13-15, 2016, "Interpreting Climate Change", a virtual course offered in partnership with the National Park Service (NPS) Mather Training Center.
This course is aimed at interpretation, education, and communication personnel, but is open to all career fields The course provides an overview of the practical knowledge and skills needed to develop effective, engaging climate change programming for both natural and cultural sites. There is no tuition to attend, and the course is open to both NPS and non-NPS sources, contingent on availability. Seats will be awarded on a first-come, first-serve basis, so early registration is highly encouraged. The deadline to apply is August 15. **Other agencies and partners are welcome to apply pending available space. Priority will be given to DOI employees. Those without DOI Learn access, please complete this Non-DOI Registration Form before August 15. You will be notified by August 17 if space is available. Contact:* matt_holly@nps.gov

October 17-21, Mountain Climate Conference, Leavenworth
The 7th Mountain Climate Conference will explore the central theme: Mountains Without Snow: What are the Consequences? In sessions on current science themes, climate policy and decision-support, MtnClim 2016 will look for opportunities to interweave discussions of the roles snowpack plays in water resources, power generation, ecophysiology, and human communities, with particular focus on the question: How ready are we to foresee the full range of consequences of mountains without snow?

November 14-16, the 7th Annual Northwest Climate Conference, Skamania Lodge, Stevenson, WA.
The annual NW Climate Conference is the region's premier opportunity for a cross-disciplinary exchange of knowledge and ideas relating to climate impacts and adaptation. The conference brings together up to 400 researchers, resource managers and policy makers from academia, public agencies, sovereign tribal nations, non-governmental organizations, and the private sector, to share the latest climate science, challenges to infrastructure, industry, environment and communities, and adaptive solutions.

Free Open Course: Managing for a Changing Climate
The South Central CSC is launching a free online course, open to the general public, on August 17, 2016. This course will provide an integrative understanding of the components of the climate system including the range of natural climate variability and external drivers of climate change, in addition to impacts of a changing climate on multiple sectors such as the economy, policy, ecosystems, and indigenous populations. Learn more >>

New Proceedings of a Workshop: Characterizing Risks in Climate Change Assessments
As part of its legislative mandate, the U.S. Global Change Research Program (USGCRP) develops periodic National Climate Assessments (NCA) on key issues related to climate change. In March 2016, the Academies' Board on Environmental Change and Society convened a workshop to address a key issue for NCAs: providing information about climate-related hazards, risks, and opportunities in formats that are

understandable, credible, and useful to decision makers. Participants, including federal agencies, small municipalities, citizens, communities, and businesses shared their experience in using such information in their efforts to reduce greenhouse gas emissions, reduce vulnerability, and increase resilience to climate change. View the workshop materials and read or download the new Proceedings of a Workshop today.

View Webcast Video: Seminar on Moving on From Paris

In case you missed the April 28th seminar "Moving on From Paris: Implementation Lessons from Social Science," a video of the webcast is now available. The seminar explored the benefits and risks of the voluntary bottom-up approach crafted at the 2015 UNFCC Paris climate summit, in which 196 countries pledged to meet global mean temperature targets by 2100. A specific focus of the seminar was how behavioral and societal responses have or have not been included in the modeling of temperature targets. View the video of the webcast here.

CLIMATE SCIENCE NEWS

2015 State of the Climate released – *from Climate.gov*

The *State of the Climate in 2015* report, compiled by more than 450 scientists from 62 countries around the world, confirmed that 2015 surpassed 2014 as the warmest year since at least the mid-to-late 19th century. The record heat resulted from the combined influence of long-term global warming and one of the strongest El Niño events the globe has experienced since at least 1950. Most indicators of climate change continued to reflect trends consistent with a warming planet. Several markers, such as land and ocean temperatures, sea levels, and greenhouse gases, broke records set just one year prior.

Report Highlights »

Full Report »

July 2016 ENSO discussion - Enjoy neutral while it lasts! – *(from Climate.gov)*

Blogger Tony Barnston describes how the transition from ENSO-neutral toward La Niña is progressing, and explains why models have become somewhat less bullish on the certainty and strength of the La Niña.

Get the Full Story »

You Might Also Like: The life and death of El Niño »

August Newsletter from the Washington State Climatologist

The August newsletter is now available on our website (http://www.climate.washington.edu/newsletter/). Topics include July climate summary, US Drought Monitor and streamflow update, a note on clouds and maximum temperatures in WA, temperature and precipitation outlook. Please direct any questions or comments to climate@atmos.washington.edu.

People's observations provide a vivid picture of climate shifts, and could help guide adaptation policies

Canadian scientists have collected stories from more than 90,000 people whose traditional ways of life rely on nature, in an effort to capture signs of climate change where weather stations are absent. Their findings, published in the journal Nature Climate Change, fill a knowledge gap in climate change science, which is dominated by data and computer models. Learn more >>

Five centuries of U.S. west coast drought – *from the NPLCC*

The drought along the west coast of the U.S. that began in 2012 formed in relation to a high-pressure ridge linked to internal atmospheric variability. In this recently published study, University of North Carolina scientist Erika Wise examined this most recent drought (the occurrence, spatial patterns, and associated circulation features) through a paleoclimate context by linking atmospheric circulation to surface hydroclimate patterns. Spatial reconstructions of upper atmosphere pressure patterns and cool-season drought showed that drought along the U.S. west coast has occurred periodically since 1500 C.E. These droughts were also found to be associated with a strong ridge centered along the Pacific Northwest coast.

Ocean's oxygen running low – *from the NPLCC*
University of Washington oceanographer Curtis Deutsch and colleagues have recently published a new study examining the distinction between naturally varying and climate-induced declines in dissolved oxygen levels of the world's oceans. Using a large ensemble of a single Earth System model, the authors developed a global map of changing oxygen levels and found that it was possible to discern climate-driven changes from other sources. They found that for each degree of warming, oxygen concentration declined by 2 percent. Warmer waters lead to a more stratified ocean which consequently cuts off oxygen supply to habitable parts of the marine ecosystem. Furthermore, increased ocean temperatures cause the metabolic rate of marine species to increase, thus requiring increased oxygen consumption. Global Biogeochemical Cycles Journal article

Climate Change may already be shifting clouds over the poles *(from Oregon Public Broadcasting)*
The way clouds cover the Earth may be changing because of global warming, according to a study that used satellite data to track cloud patterns across about two decades, starting in the 1980s. Clouds in the mid-latitudes shifted toward the poles during that period, as the subtropical dry zones expanded and the highest cloud-tops got higher

NOAA News
June marks 14 consecutive months of record heat for the globe

Increasing western US forest wildfire activity: sensitivity to changes in the timing of spring – *(from the NPLCC)*
Large forest fires and the areas burned have continued to increase, according to a recent study. Areas in the Pacific northwestern and southwestern forests have substantially increased in number of fires in recent years. The study shows that wildfire activity is strongly associated with warming and earlier spring snowmelt. Areas of forested lands with earlier spring snowmelt have been most greatly affected due to the loss of moisture.

Long-term Pacific climate cycle linked to expansion of Antarctic sea ice - *(from the NPLCC)*
According to a paper published in Nature Geoscience, the trend of increasing Antarctic sea ice can be mostly explained by a natural long- term climate fluctuation. The study seeks to explain why Antarctic sea ice is expanding despite climate-related global warming. The research offered evidence that the current negative phase of the Interdecadal Pacific Oscillation, which brings cooler-than-average sea surface temperatures in the tropical eastern Pacific, has created favorable conditions for additional Antarctic sea ice growth since 2000. The ultimate impact is a deepening of a low-pressure system off the coast of Antarctica known as the Amundsen Sea Low. Winds generated on the western flank of this system blow sea ice northward, away from Antarctica, helping to enlarge the extent of sea ice coverage.

Flows of the future—How will climate change affect streamflows in the Pacific Northwest? – *(from the NPLCC)*
Much of the water supply in the Pacific Northwest originates in national forests. It sustains the region's

aquatic ecosystems, agriculture, hydroelectric power, and community water supplies. Understanding how climate change will affect water supply is one of the most pressing issues of our time. Substantial changes are projected in the types of precipitation (rain vs. snow) that will fall in the region, as are smaller, but potentially important, changes in the total annual precipitation. Combined with earlier snowmelt, these changes could cause decreased summer streamflows, and some high-elevation streams may dry up.

SPECIES AND HABITATS

New Publication: Climate Change and Distribution of North American Birds - *(from Bioclimate, the newsletter of the National Climate Change and Wildlife Science Center)*
A new study of population trends among 46 bird species in North America overturns a long-held assumption that the climate conditions occupied by a species do not change over time. In a recent publication in *Global Ecology and Biogeography*, Northeast CSC researchers suggest that birds contract or expand their climate condition ranges as they decrease or increase in abundance. Learn more >>

Nutrients and Climate in the North Pacific – *(from the Climate Impacts Resource Center)*
Almost 20 years ago, Nate Mantua and colleagues at the University of Washington noted a strong link between salmon abundance and patterns of sea surface temperature (SST) in the north Pacific Ocean. But the direct connection between SST and salmon abundance was unclear. Because salmon are high-level predators, their abundance can depend on several trophic levels below them and on the biochemical properties of the water itself. Now, new work by a team of Japanese and Canadian scientists has assembled a dataset of nutrient concentrations that helps fill in the picture. (Continue Reading →)

Ocean acidification will make it hard for mussels to hang on – *(from NPLCC)*
According to a presentation by Emily Carrington, a professor at the University of Washington in Seattle, at the annual meeting of the Society of Experimental Biology, warmer ocean temperatures and rising ocean acidification levels are posing a threat to mussels. Mussels use the stretchy fibres that Carrington is studying, known as byssal threads, to glue themselves to a rock, rope or boat that will be their permanent home. They eat by filtering plankton from the water. If those threads break — or fail to attach at all — the mussel will be tossed from the tidal zone it thrives in to deeper, calmer waters, with less food and more predators. Warmer water means the native mussel - Mytilus trossulus, produces fewer, weaker threads. More acidic water means the biological 'glue' — which needs higher pH doesn't stick as well.

Ocean Acidity to Blame for Thinning Mussel Shells
Increasing ocean acidity from climate change is one cause of thinning California mussel shells, according to a new study in *Proceedings of the Royal Society B*. University of Chicago biologists compared the thickness of modern mussel shells with those collected in the past, some thousands of years ago by Native Americans, and found that the old shells were 27-94% thicker. Learn more >>

Managing forests in the face of drought and changing climate
Special issue of Western Forester on managing forests in the face of drought and changing climate.

In Hot Water: Climate Change Is Affecting North American Fish – *(from BioClimate, the newsletter of the National Climate Change and Wildlife Science Center)*
Climate change is already affecting the growth, reproduction, and geographic range of inland fish across North America – including some fish that are popular with anglers. Scientists supported by the National Climate Change and Wildlife Science Center document a variety of climate change related changes in fish in four synthesis studies published last week in a special issue of *Fisheries*. Learn more >>

Old Growth May Help Protect Northwest Forest Birds from Climate Change - *(from BioClimate, newsletter of the National Climate Change and Wildlife Science Center)*
Northwest CSC scientists recently found air temperatures in old growth forest to be a surprising 2.5 degrees cooler than in similar closed canopy plantations that were logged 60 years ago. This research suggests that old growth forests could help buffer cool temperature associated bird species from anticipated warming. Learn more >>

Eastern U.S. Lacks Connectivity to Help Species Escape Climate Change -- *(from BioClimate, the newsletter of the National Climate Change and Wildlife Science Center)*
The eastern U.S. will need improved "climate connectivity" for plants and animals fleeing the effects of climate change to have a better shot at survival. A new publication in *Proceedings of the National Academies of Sciences* shows that less than 2 percent of the eastern U.S. currently provides suitable connectivity. Learn more >>

USFWS agrees to evaluate moose in Minnesota for possible ESA listing based largely on climate concerns *(from The Wildlife Society)*
The northwestern moose (Alces Alces andersoni) will be further considered for listing under the Endangered Species Act, according to a 90-day finding by the U.S. Fish and Wildlife Service. A formal petition for the species was submitted in 2015 by the Center for Biological Diversity, requesting that USFWS list the species under the Endangered Species Act as a distinct population segment in northern Minnesota, northeast North Dakota, the Upper Peninsula of Michigan, Isle Royale, and Wisconsin. Moose populations in other parts of the country were not addressed in the petition, and therefore will not be reviewed by USFWS. The northwestern moose population has declined over the past decade due to climate change, habitat degradation and disease, among other threats. In Minnesota alone, the populations have declined over 60 percent in the last decade.

Cue the Frogs! Water signatures, environmental cues and climate change – *(from California Water Blog)*
In many species, we only have some understanding of environmental cues and what disrupts them. Better understanding cues can help managers implement restoration and protection actions. A team of researchers at UC Davis has been exploring environmental cues for the foothill yellow-legged frog [FYLF] (*Rana boylii*) in rivers in the Sierra Nevada. Significant work has identified suitable breeding and rearing habitat conditions for these river-breeding frogs, which have adapted to California's seasons and are genetically wired to lay eggs during the spring snowmelt when river flows recede and water temperatures increase.

How biodiversity buffers fisheries against climate change – *(from NPLCC)*
An international team of researchers used data collected by citizen scientist SCUBA divers at nearly 2,000 sites around the world to investigate relationships between biodiversity and biomass. They found that warmer water temperatures increase biomass, but temperature variability decreases it. They also found that sites with greater species richness and diversity had higher biomass, and that species diversity was the second strongest predictor of biomass. Analysis showed that, while changing temperatures did reduce reef fish biomass, the effect was halved in the most diverse ecosystems. That's "possibly because species-rich communities harbor fishes with a range in thermal niches," speculate the authors. More biodiverse ecosystems are simply more likely to include fish species able to withstand the coming changes.

Squid Are Thriving While Fish Decline – (*from the NPLCC)*
This study represents the first global-scale database of cephalopod population numbers from 1953 to 2013. The authors compiled historical catch rates for 35 species from all over the world and found consistent

increases across the three cephalopod groups in all habitat types, from open ocean to tidepools. These results contrast starkly with population patterns in marine vertebrates, many of which declined by nearly half from 1970 to 2012. The authors are currently investigating potential causes of the increase in cephalopods, but suspect that climate change and overfishing may play a role. Warming oceans, while detrimental to some fish, may create beneficial growing conditions for some cephalopods, and overfishing could potentially reduce cephalopod predators. New York Times Story

Scientists create new model to map warming-related threats – *(from the NPLCC)*
Scientists from Washington State University recently published a study on how U.S. forests will respond to climate change. The authors developed a new quantitative tool, called a Tolerance Distribution Model, that allows for the assessment of landscape-level impacts of climate change. Using this model, the scientists were able to project how forests will change in composition and range across North America. Included in their findings was a projection of the Pacific Northwest; as this region continues to get warmer and wetter, it may become more conducive for forests species currently growing in south-eastern China, southern Brazil, or sub-saharan Africa. Climate Change News article

Plants' ability to slow climate change depends on their fungi *(from Imperial College, UK)*
Scientists have discovered why only certain plants can take in extra carbon dioxide when levels rise and help to reduce global warming.

NOAA study finds 'living shorelines' can lessen climate change's effects – *(from NOAA)*
A recent NOAA study, published in the journal PLOS One, shows "living shorelines" — protected and stabilized shorelines using natural materials such as plants, sand, and rock — can help to keep carbon out of the atmosphere, helping to blunt the effects of climate change. This study, the first of its kind, measured carbon storing, or "carbon sequestration," in the coastal wetlands and the narrow, fringing marshes of living shorelines in North Carolina.

POLICY, MANAGEMENT AND EDUCATION

Ecology releases updated rule to cap carbon pollution
After incorporating feedback from business and environmental stakeholders, the Washington Department of Ecology has released an updated version of the state's first-ever rule to cap carbon pollution. The Clean Air Rule will reduce carbon pollution to help slow climate change. Washington faces severe economic impacts from the changing climate. The proposed rule would set limits on carbon pollution (greenhouse gases) to help slow climate change and limit expected damage to the state's rich agricultural resources, drinking water supplies, and infrastructure. The rule would require businesses and organizations that are responsible for large amounts of greenhouse gases like natural gas distributors, petroleum product producers and importers, power plants, metal manufacturers, waste facilities, and others to show once every three years that they're reducing their emissions an average of 1.7 percent annually.

U.S. Senator introduces bill to establish climate change education program – *(from EPA State Climate and Energy News)*
U.S. Senator Ed Markey introduced legislation designed to help educate Americans about climate change. The "Climate Change Education Act" (S.B. 3074) directs the National Oceanic and Atmospheric Administration (NOAA) to establish a climate change education program focused on formal and informal learning for all age levels. The legislation also intends to establish a grant program to support public outreach programs that improve access to clean energy jobs and research funds intended to help local

communities address climate mitigation and adaptation issues. The bill is available at: http://www.markey.senate.gov/imo/media/doc/ClimateChangeEductionAct-2016-06-16.pdf.

State Innovation on Climate Change: Reducing Emissions from Key Sectors While Preparing for a "New Normal"

A new Georgetown Climate Center article in the Harvard Law and Policy Review describes the efforts of states to reduce greenhouse gas emissions from two major sectors (transportation and electricity) and to prepare for the impacts of climate change. By examining state innovation, lessons can be shared with other states and the federal government to inform decisions regarding future national and international efforts to curb climate change and adapt to its consequences.
VIEW THE ARTICLE

West Coast leaders have signed a climate agreement that would see an electric-vehicle charging network from Vancouver to Los Angeles – (from the NPLCC)
Representatives from the governments of BC, Washington, Oregon and California and the cities of Los Angeles, Oakland, Portland, San Francisco, Seattle and Vancouver met last Wednesday in the Golden Gate city to sign the Pacific North America Climate Leadership Agreement. The accord—covering a region home to some 53 million residents and sometimes romantically referred to as 'Cascadia'—aims at an integration of low-carbon policies and achieving common metrics and standards across all jurisdictions, emphasizing buildings, transport, waste and energy.

Olympia prepares for rising sea levels with a $60M plan to keep it above water - *(from the DJOC)*
Future projects could include landscaping, flood barriers, storm drainage, and elevating buildings and roads.
By early 2018 the city expects to recommend to the City Council specific projects to address the effects of rising sea levels, including a funding strategy and regulatory recommendations. A 2011 estimate put the implementation cost at around $60 million.

EPA Determines that Aircraft Emissions Contribute to Climate Change Endangering Public Health and the Environment

The U.S. Environmental Protection Agency (EPA) finalized a determination under the Clean Air Act that greenhouse gas (GHG) emissions from certain types of aircraft engines contribute to the pollution that causes climate change and endangers Americans' health and the environment. The findings are for carbon dioxide (CO2), methane, nitrous oxide, hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF6), all of which contribute to GHG pollution that represents the largest driver of human-caused climate change. These particular GHGs come primarily from engines used on large commercial jets.

The Youth Climate Summit Scale-up Initiative

The Youth Climate Summit is designed to engage high school students in climate literacy through meaningful dialogue and action planning on climate change.
Learn more »

Climate Explorer - Cooling Degree Days

Cooling degree days reflect the amount of energy people use to cool buildings during the warm season